The MAC Flyer

JUNE 1973

MILITARY AIRLIFT COMMAND
GEN PAUL K. CARLTON Commander
LT GEN JAY T. ROBBINS Vice Commander
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COL B. J. MASSINGILL Chief, Safety Division

For Greater Efficiency
in MAC Air Operations

The MAC Flyer

THE STAFF
LT COL RICHARD L. WING Supervising Editor
MAJ ROBERT L. GARDNER Associate Editor
CAPT PHILLIP R. BUDD Associate Editor
MARILYN A. BOLIEAU Managing Editor
TSGT WAYNE L. MILLS Art Director
SSGT EUGENE REECE Staff Artist

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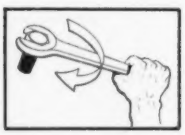
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COVER: Operations — the action agency of MAC. This issue focuses on the past, present, and future of MAC air operations.

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Squawk Box

This month marks the beginning of something new in The MAC Flyer. As you can tell from the features listed in the index, this issue has a very definite operational flavor. The articles include discussions of four accidents, a look at the risks of marijuana for flight crews, a review of the new RNAV systems, a report on C-5 simulator training for navigators, and some suggestions on planning ahead for helicopter emergencies.

While emphasizing operational matters is not new, the concept of focusing on a specific staff agency and of having a representative of that agency act as a focal point for developing article ideas and finding authors is. The contact man for this month was Major John Livingstone, assigned to the Directorate of Aircrew Standardization.

This new approach underscores the concept that this **is** your magazine. It belongs to everyone in MAC, especially the flight crews and their supervisors up the line. After all, there is no such thing as pure flying safety. Each of you has a job to do, and if that job is performed efficiently, safety is a natural by-product.

To the end of increased operational effectiveness and enhanced knowledge, I encourage you to absorb the wealth of material offered in these pages. I also encourage you to consider sharing the special knowledge you possess by taking the time and effort to contribute an article or idea to the magazine staff. The result will be a better magazine — and enhanced effectiveness of the command.

The handwriting is on the wall. It's just a matter of time before we'll hand in our wings and check out a computer.

RNAV Means Kiss Your 'Gator Good-by

by Maj John R. Livingstone, MAC/DOV

The relentless pace of technology has almost completely eliminated the word "art" from the definition of navigation. In fact, the days are numbered for the practitioners of navigation. Just as nature forces the aged ones from control to make room for youth, so must we accept the forced retirement of the human navigator as automation reaches maturity. Present RNAV systems have such tremendous growth potential that we almost feel we are on the edge of "Buck Rogers" world. But

before we look at what's in store, review these definitions.

Definitions

RNAV — A system of routes designed to provide RNAV equipped aircraft route availability from wheels-up to wheels-down. Ground controllers assume a passive role for en route and terminal navigation. Growth to data link control of all flight phases is envisioned.
NAS — National Air Space.
STAR — Standard Terminal Arrival Routes.
Delay Fans — Systems for traffic spacing.

RNAV Dimensions:
2D — position in terms of latitude/longitude.
3D — position in the vertical plane (VNAV).
4D — position referenced to time.

Navigation Systems:
Theta — A radial or bearing; VOR for example.
Rho — A distance (tacan, DME).
Rho/Theta — Mix of bearing and DME.
Rho/Rho — Two DMEs used as a fix.
INS — Inertial Navigation System.
Omega — A system of hyperbolic lanes similar to loran for position fixing.

Terminal Area — Based on 1982 projections, includes all airports within terminal complex.
High Density Terminal — Over 400,000 instrument operations/year.
Medium Density Terminal — 200 - 400,000 instrument operations/ year.
Low Density Terminal — Less than 200,000 instrument operations/year.

What is RNAV (or area navigation, for long)? Basically, it is a nation-wide system designed to provide a complete route structure from wheels-up to wheels-down. It will provide positive control in all four of the NAS dimensions (latitude, longitude, altitude, time; expressed as 4D). With airborne computers handling most of the work, ground controllers will assume a passive role (no more vectors) for en route and terminal navigation. Eventually, growth to data link control is envisioned — perhaps as little as ten years from now.

The magnitude of the change is going to be so great that much of our present nav gear will go the route of wooden props and tail wheels. Are you just beginning your flying careers today? When you are an old and gray crewmember (say age 36-40 years), you'll reminisce over coffee and say, "I remember when we flew around with nothing but dopplers and sextants." Those of the younger breed will then shake their heads, nod sagely, and think you were nuts.

Where did all this begin? In 1972, when an aviation and air-space symposium was held in Washington, D.C. It brought together members of the avionics industry, aircraft industry, government, and civilian airspace users to discuss ways to relieve aerial congestion. The attendees agreed that the U.S. needed to increase the capacity of our air traffic control system and to reduce its operating costs. They felt the best way to achieve more efficient use of the airspace was to develop more efficient air traffic control methods. Most specifically, they were concerned with the future direction of RNAV.

As a result of their meeting, an aviation industry-wide Area Navigation Task Force was formed. The Task Force's mandate was to determine the best possible navigation system for the NAS achievable in the next decade, 1972-1982. The Area Navigation Task Force submitted its formal report in early 1973. In it, they addressed the RNAV system design concept in three time phase periods: 1972-1977, 1977-1982, and from 1982 on.

First Phase

The first phase is from 1972-1977. In this period, a dual VOR/RNAV navigation system is proposed. The primary navigation system will still be VOR (theta), with limited use of vertical area navigation envisioned. In radar terminal areas, RNAV routes compatible with the current optimum radar vector flight paths will be established. As the number of RNAV equipped aircraft increases, more use will be made of parallel offset capabilities and delay fans to achieve separation and spacing on final approach course. Also, 2D and 3D RNAV approaches will be developed for all airports where user requirements exist.

Second Phase

In the second phase, 1977-1982, we will begin to see some features affecting MAC operations. Above FL 180 and in high density terminal areas, RNAV will be the sole navigation system. Within the next four to nine years, VOR routes will be deleted! How about that?

A much broader use of VNAV (latitude, longitude, altitude; or 3D) is envisioned, and therefore VNAV equipment will be required. In selected high density terminal areas, those with automated spacing and metering, a time (4D) capability may be required.

Route width will be modified. In the terminal area routes will span 1.5 NM either side of centerline, while en route widths will be reduced to 4 NM either side of centerline.

Terminal patterns will be redesigned. Since the performance of a Boeing 727 aircraft represents a median, it will be used to establish design factors. Terminal RNAV SIDs and STARs will be used to the maximum extent. The terminals will have eight 45 degree sectors, four for departures and four for arrivals, with the arrival sectors separated by the departure sectors (figure 1).

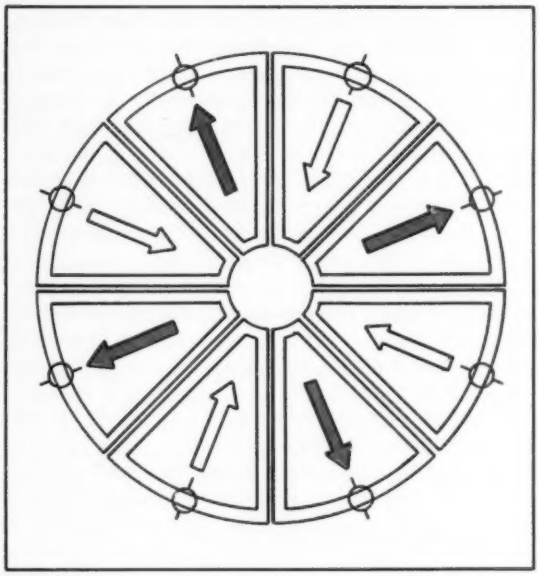


Figure 1. Around each terminal will be four arrival and four departure sectors.

During this second period, the controller's role will be changing from active to a passive, and RNAV-equipped aircraft will be permitted to use the equipment to the fullest extent. (Guess who gets priority?)

INS aided by rho/theta and rho/rho and/or omega will constitute the onboard navigation system. As a result of this, VORs and TACANs will be relocated and 2D procedures for military terminals will be designed. Full 4D procedures will be developed for high density terminal areas.

The 1977 system will be quite capable of handling traffic demands forecast beyond 1980.

Third Phase

In the third phase — 1982 plus — the system is expected to provide full-time conflict detection and resolution, traffic flow control linked with the terminal metering and sequencing functions, and transmission of control instructions via data link. There will be no requirement for published RNAV routes since all routes will be great circle from terminus to terminus, altered as required by traffic or weather.

In this environment, the pilot will simply file departure point, departure time, destination, and altitude. His routes will be assigned via data link.

Improved altimetry will permit use of 1,000-foot vertical separation above FL 290, and composite separations are envisioned — three tracks laterally spaced by 4 NM with the center track vertically displaced by 1,000 feet. (Development criteria assume a 95 percent probability factor that an aircraft will remain within the laterally protected airspace prescribed.) Normal route widths will compress to 2.5 NM either side of centerline, but will remain at 1.5 NM in the terminal areas.

Above FL 180, RNAV will be the system,with both RNAV and VNAV capability required for all altitude operations. While the concept of 4D is still rather vague, I feel that all high and medium density terminal areas will probably be using this concept.

Gear

What kind of equipment does this concept require? Really, it is not that complex in today's avionic world. It will require sensors to provide navigation signals (DME, INS, omega, etc), a computer to process the information, and a cathode ray tube (CRT) for visual presentation of all pertinent flight parameters. Basically, the CRT will display airplane position, relative position, timing, and flight plan data.

You will hear the terms Mark II and Mark 13 associated with RNAV. Mark 13 systems will meet the requirements of the 1972 - 1977 time frame, and Mark II systems will be geared to the 1982 and beyond period. The Mark II systems may cost from 45 to 100 thousand dollars a copy; the Mark 13s will cost 30 to 45 thousand, depending on the degree of sophistication. For example, do you want the computer to have waypoints manually

stored or card stored? Do you want all flight plans indigenous to your mission prestored for call-up? You get what you pay for.

So what's that got to do with MAC? Well, friends, I think MAC will probably be affected more than any other DOD agency. After all, we work in the airspace with our civilian brethren every day and we must be able to compete in that airspace. That means we must have the equipment to do the job.

It was mentioned earlier that navigators may become obsolete, and there has already been some talk about reducing our navigator force. If we wish to seriously address removing navigators, we must also address RNAV equipment acquisition. To provide maximum heads-up time for the pilots, RNAV will become a necessity. RNAV gathers the navigation data from the various sensors and presents it to the pilots in an easy-to-read, highly usable format. Responsibility for navigation will be moved back to the cockpit and away from the controllers.

Major Livingstone predicts rated force extinction.

Crystal Ball

Let me prognosticate for you.

- Time: June 1984
- Place: Travis
- Object: Flight

The preflight complete, our pilots take their seats. The copilot calls, "Oakland, MAC 1234. Travis spot 30, active runway 03, destination Scott, request 1000 takeoff, flight level 290."

"Roger MAC 1234, stand by."

Seconds later, the alert push button on the navigation panel illuminates and the pilot presses the button. His clearance appears on the screen. "MAC 1234, cleared KSUU to KBLV FL 290. Takeoff time 1001, runway 03, SID 23, GC, Scott feeder fix 5, STAR 32 Scott, controlled arrival time 1404. ADVANCE FRAME."

The pilot advances the frame. His taxi instructions appear on the screen, and he taxies out for takeoff. At 1001, he engages the autopilot. The throttles advance and away they go.

His RNAV computer takes him through the SID, controls his vertical flight path, and rolls him out on the great circle course to Scott feeder fix 5. The SID waypoints, timing, and en route information are automatically sequenced on his cathode ray tube.

At 1330, the alert push button flashes as the airplane turns. The pilot depresses the button. A printout appears: "Large TSM 50 NM at 12 o'clock. We are diverting you to a parallel track 20 NM north of present track." The pilot yawns and takes another sip of coffee.

At 1340, the alert push button again flashes. Once more the pilot depresses the button as the airplane turns and he reads: "Conflicting traffic dictates diversion to Scott feeder fix 4. Cleared STAR 34 to runway 31. Descent begins in four minutes."

At 1344, the VNAV light illuminates. Another push at the button and the screen depicts the vertical flight path and pertinent information for the STAR.

How come the pilots haven't been tuning their radios? Simple: The computer has automatically measured signal strength and optimum geometry and selected the best available aids. The controllers, via data link, have tracked the aircraft's position and fed appropriate corrective commands to the autothrottles for real time resolution.

At 1403:58, the aircraft lands. The CRT signals to advance frame; the pilot does and reads his taxi instructions to a parking spot. End of mission.

* * *

The capability to fly such a mission is not from the dream world. Most of it can be done now, and the rest will surely come. The Task Force says 4D RNAV is but nine short years away. Yes, the end is in sight for navigators.

But we're only the first of the fraternity to face extinction. It took twenty years from the heyday of the navs to their replacement by a black box. Keep this in mind, pilots — in an ever-faster-moving technological society, you also must face the inevitability of obsolescence. 1995 . . . ? Maybe.

As I sit here with my coffee, I remember when . . .

Global Notes

outstanding safety contributions

On 3 November 1972, a T-29 crew from the Civil Air Patrol experienced an airborne emergency when the landing gear would not extend on approach to Westchester County Airport, New York. They diverted to McGuire AFB for a possible gear-up emergency landing, and a phone patch was put through to Scott. Maj Arthur C. Aho, Jr., 375 AAWg, provided technical assistance from the HQ MAC Command Post through communication with the McGuire tower personnel. After all normal and emergency gear extension procedures had been exhausted without success, Maj Aho recommended a procedure which is not in the T-29 Dash One. He told the aircrew to place negative Gs on the aircraft while simultaneously extending the landing gear. The gear came down and an accident was averted.

On 5 February 1973 while Lt Col Maurice F. Golden, Jr., 375 AAWg, was on a local training mission in a T-29, he was advised by Scott that a Cessna 150 was reportedly lost 15 miles south of Scott AFB and had developed engine problems. The Scott weather, 800 feet overcast, precluded the Cessna's non-instrument rated pilot from attempting a landing. Approach Control vectored Col Golden so he could aid in the Cessna's approach to Scott. Col Golden established VFR contact with the Cessna and lead it to a safe landing. The Cessna ran out of gas while taxiing to the ramp.

on-time record?

SSgt Stephen C. Pattengale, a crew chief for McChord's 62d Organizational Maintenance Squadron, and his crewmembers set a wing and possibly even a MAC reliability record. His team has been able to ready their C-141 for 88 consecutive on-time takeoffs.

Capt Gary D. Brackett, officer in charge, and Sgt Pattengale explained that in order for such a record to be attained, the aircraft must meet many continuing scheduled inspections and maintenance programs as well as undergoing normal post flight debugging. And all this must be done so the aircraft can depart at the time set by mission requirements.

To what does Sgt Pattengale attribute his record? "I feel that it's mostly working with good people," he stated, "and having good luck."

personnel changes

TSgt Wayne L. Mills, our former art director, was presented with bound volumes of **THE MAC FLYER** published during his tenure on the staff. The August 1969 to May 1973 volumes were presented by Lt Col Richard L. Wing, Supervising Editor, in a ceremony held prior to Sgt Mills' departure for assignment with HQ Pacific Communications Area at Wheeler AFB, Hawaii.

Above: TSgt Wayne L. Mills receives bound volumes of The Flyer.

Below: Our new art director, SSgt "Geno" Reece.

Back with us again as art director is SSgt Eugene Reece, better known as Geno Reece. He had previously been on our staff from October 1966 to March 1970.

For safe air operations, discipline and judgment are as important as tech data knowledge. Two pilots who disregarded all three ingredients caused a costly accident.

Mishap with a Moral:

it's all in the approach

by Capt Phil Budd

(facts taken from NTSB report AAR-72-31)

In our continuing effort to learn from mistakes of others, we present this review of a civilian aircraft accident. No comparison is drawn between this accident and any military accident. However the history of flight, investigation, and conclusions of the National Transportation Safety Board's investigators will certainly remind all who fly that discipline and good judgment play a major part in aircraft safety.

The flight was a scheduled passenger run from Miami to Cleveland with one stop at Fort Lauderdale. Eleven minutes after takeoff from Miami, the aircraft crashed on the runway at Fort Lauderdale. The aircraft was destroyed, but the crew and all passengers survived.

History of Flight

Eastern Airline (EAL) Flight 346, a DC-9, departed Miami International at 1511 EST on an IFR flight plan. After takeoff, the crew received a radar vector to Fort Lauderdale VOR from Miami departure and were instructed to contact Miami approach, the controlling agency for the Fort Lauderdale airport. The approach controller cleared them for an ILS to runway 9L and gave them a vector to intercept the localizer, informing the crew they would be following a similar-type aircraft. Approximately five minutes after departing Miami, the EAL crew were cleared to descend to 2,000 feet, and at this time they were advised the weather was currently estimated 700-foot overcast, one-half mile visibility with thunderstorms and heavy rainshowers. The EAL crew acknowledged the weather.

The DC-9 ahead of the Eastern flight was also given this weather, and they requested and received a missed approach. They remarked, "We need three-quarters of a mile to complete the approach."

The EAL crew continued their approach and were then informed by the controller that the glide slope was out and they would have to make a localizer-only approach. The controller also queried the EAL crew if the weather was adequate; would they be making an approach? The EAL crew replied that 700 feet would be enough. The controller cleared them for the approach and to descend to 1,700 feet. (The published visibility minimum for the ILS approach to runway 9L is three-quarters of a mile. Without glide path it is one mile.)

(FAA Terminal Air Traffic Control Handbook says, "Do not withhold a landing clearance indefinitely even though it appears a violation of FAR has been com-

mitted. The apparent violation might be the result of an emergency situation. In any event, assist the pilot to the extent possible." A note associated with the reg says, "Acceptance of a radar approach by a pilot does not waive the prescribed weather minima for the airport or for the particular aircraft operator concerned. The pilot is responsible for determining if the approach and landing are authorized under the existing weather minima.")

The controller then gave the crew another vector and cleared them for a straight-in localizer-only approach. He also advised the EAL crew again that the glide path was inoperative and to contact Fort Lauderdale tower. The flight had now been airborne approximately six minutes.

On initial contact, tower advised the EAL crew about the deteriorating weather and asked them to report at the outer marker inbound. Two minutes later the tower controller advised them of the 700-foot ceiling and half-mile visibility. Ten seconds later the tower operator reported the glide path back in and then immediately reported it back out. The EAL crew did not acknowledge these transmissions.

Three minutes later (11 minutes after takeoff from Miami) the tower controller saw the Eastern DC-9 sliding down the runway, on fire, and barely visible because of heavy rain. The tower controller activated the primary crash net, and rescue and fire fighters responded and extinguished the fire.

The landing gear failed on impact and the tail section broke off aft of the wings. A post crash fire destroyed the aircraft. All the passengers and crewmembers safely evacuated the aircraft.

Investigation

Both pilots were certified and current in the DC-9. Their flight planning was adequate. Their preflight weather briefing was a self-help type; a company or National Weather Service (NWS) briefing was not provided.

While the NWS does not prepare a terminal forecast for Fort Lauderdale, the 24-hour terminal forecast for Miami, issued about an hour and a quarter before takeoff, was:

> Ceiling 2,000 foot broken, broken clouds variable to scattered, occasional ceiling 800 foot overcast, visibility 2 miles, thunderstorms, moderate rainshowers.

The EAL terminal forecast was:

> 3,000 scattered variable to broken, scattered moderate rainshowers or thunderstorms

with light rainshowers until 2000, thereafter 1,500 overcast, light rainshowers or thundershowers with light rainshowers.

The captain testified that he was acting as copilot on this leg and the first officer was flying the plane from the right seat. He said the flight to Fort Lauderdale was in visual conditions from Miami to Fort Lauderdale. During the flight, he spent most of his time talking to company while the first officer monitored air traffic control on another radio; the first officer was to relay any pertinent information to him. According to the captain, the only information about the terminal weather that the first officer relayed to him was the 700-foot ceiling. The first officer made no mention of the visibility, rainshowers, or thunderstorms. The first officer testified that he heard the 700-foot ceiling report but did not recall hearing the visibility as a half mile. He did testify that he acknowledged the weather report and this was confirmed by the voice tapes.

The first officer commenced the approach and configured the aircraft according to the captain's instructions — gear down, flaps 25 degrees. (Company directives state that flaps should be set 50 degrees at the outer marker on an ILS approach. The cockpit voice recorder showed that the flaps were positioned after the outer marker and that standard challenge - response checklist items were performed improperly.) The captain testified he had the runway in sight during the entire approach, and, as the first officer leveled at MDA, the captain felt they were high and close (to the runway) and immediate action had to be taken to remain visual and land within the touchdown zone. The captain took control and put the flaps to 50 degrees and closed the throttles. From this point the rate of descent increased as he made an effort to stay visual. At about 200 feet the captain said they flew into a virtual wall of water. The first officer then said the runway was right beneath them so the captain pulled back on the yoke, but it did not seem to respond like it should have. He said it felt like he was in a severe downdraft. The aircraft then hit the runway.

Let's stop a second and recap. The crew was certified and qualified. They had properly flight planned. During the approach, the weather changed very rapidly from that reported during flight planning. The aircraft and its power plants were operational until impact. The reported visibility for the localizer-only approach was below authorized landing minima. The existing weather was reported to the crew and was acknowledged. The captain initiated an approach for landing when the visibility was less than authorized. The crew did not report at the outer marker as requested by the tower nor did the crew receive a clearance to land by the tower.

Conclusions

Although operational control of a flight is shared by the pilot and the company aircraft dispatcher (according to federal air regulation), it was the pilot in command on this flight who had to make a decision pertaining to the weather. With the rapidly changing weather conditions, it would have been near impossible for the dispatcher to stay ahead of the weather conditions. The pilot and the tower operator were the only ones in a position to do this.

As always, the ultimate responsibility for the safety of passengers, crew, and aircraft rests with the pilot in command. Further analysis of the pilot's management of this crew showed that crew coordination and performance were undisciplined.

Probable Cause

The National Transportation Safety Board determined that the probable cause of this accident was "the decision of the pilot to initiate and continue an instrument approach under weather conditions which precluded adequate visual reference and the faulty techniques used by the pilot during the landing phase of that approach. Additionally, the flight crew's nonadherence to prescribed operational practices and procedures compromised the safe operation of the flight."

Folklore Forecasting

Man first considered the source of weather phenomena millions of years ago. In trying to predict or describe the weather, he has scientifically, and not-so-scientifically, concocted a host of explanations. Some of these are based on superstitions, others on actual occurrences. It's time to separate fact from fiction in weather lore.

If the groundhog sees his shadow on February 2, it does not mean winter will last another six weeks. It simply means the sun was at just the right brightness to create a shadow—which could be true any time.

Most of the weather lore involving our fair-weather, feathered friends, the birds, is true. For example:

Geese (and other migrating birds) fly higher in fair weather than in foul.

Sea gull, sea gull, sit on the sand; it's a sign of a rain when you are at hand.

Birds seek height in migration to make use of lofty winds. Their ceiling is lifted in good-weather, high-pressure air, and lowered in low-pressure, stormy air.

Generally, birds will roost more during low pressure than during high pressure, especially before a hurricane. Lowered pressure, just before a rain, probably makes flying more difficult for the birds.

Near the surface, quick to bite,
Catch you fish when rain's in sight.

When the wind is in the north,
The skillful fisher goes not forth;

When the wind is in the south,
It blows the fly in the fish's mouth.

These proverbs are possibilities. Both fresh and salt water fish tend to bite more before a rain. At least, that's what Izaak Walton, the famous fisherman, observed.

Face a hurricane wind and point to your right; you will point to the storm center as it moves along. This guide is usually true and useful in plotting the progress and direction of a hurricane's eye.

The old saying about crickets is another absolute.

Crickets are accurate thermometers; they chirp faster when warm and slower when cold. Count their chirps for 14 seconds, then add 40. You'll have the temperature of wherever the cricket is.

"When the leaves show their backs, it will rain" is an accurate weather predictor. A prevailing wind smooths out leaves. A rain wind shows the leaves' undersides.

The proverb about the month of March is fancy, not fact. (In like a lamb, out like a lion; in like a lion, out like a lamb.)

Rainbow in the morning, shepherd's take warning;
Rainbow toward night, shepherd's delight.

That's right. Storm centers usually move from the west. In the morning, when an eastern sun is shining on the storm, creating a rainbow, it means the storm is yet to come. An evening rainbow indicates a storm that has already passed.

While the rooster is a valuable asset on any farm, he's not a good weatherman. Neither of these almanac guidelines holds any water:

If the cock crows going to bed,
He awakens with a watery head.

Cockcrow before two in the morning,
Of two days wet it is warning.

Vermont maple syrup country proved the validity of this weatherism:

When the wind is in the east,
Then the sap will run the least;
When the wind is from the west,
Then the sap will run the best.

Even though the weatherman makes his mistakes, the chances of his being correct are much better than the proverbial almanac or your sore knee. You might try a combination weather lore/meteorologist forecast. It could be a sure-fire prediction.

It's a drag any way you look at it. A sensible crewmember wouldn't be caught . . .

Flying High

by Capt Bruce R. Fagaley, MAC/OI

Good morning, ladies and gentlemen. This is your copilot speaking. I have taken over control of the aircraft because your pilot has fallen asleep."

How would that grab you if you were a passenger on a commercial airliner?

Or how 'bout this one? "We are presently cruising at 35,000 feet, about 500 miles per hour. Our pilot is at 40,000 feet."

Maybe a better one would be: "Ladies and gentlemen, this is Anne. I'm your chief hostess. I regret to inform you that we are going to crash because the flight crew is presently stoned."

Sound ridiculous? You're right. No airline pilot in his right mind would get stoned before flying. After all, he is responsible for so many lives. And the same thing applies to a military pilot. Put yourself in the passenger's place — or even the loadmaster's shoes. Would you fly with a pilot who didn't know what was going on?

The effects of marijuana are strikingly similar to those of alcohol, and we are all aware of the potential dangers of alcohol abuse to flight crews. Therefore, one high pilot — whether from booze or grass — is just as dangerous as the other one.

Whether or not you agree with present laws concerning the use of the drug that gets you stoned marijuana — one thing all the experts agree on is that you lose perspective. Marijuana, like alcohol, takes the edge off reality. It produces a state of euphoric numbness in which perception is distorted and judgment is short-circuited.

In a study performed in the Canal Zone, 34 soldiers who used marijuana under clinical conditions showed that it had definite effects on their motor senses, vision, and reaction. These men experienced hunger, excessive eating, loss of inhibitions, an increased pulse rate, and a tendency to sleep.

If any of these symptoms affected the crew in the cockpit of the plane you are on, the results could be fatal.

Marijuana has been in widespread use for several thousand years, both for its intoxicating effects and for its presumed value as a medicine. As a medicine, it has been used for such varied complaints as pain, cough, rheumatism, asthma, and migraine headaches. But here's a word of caution before you try a bit of amateur self-medication: If you suffer from one of these afflictions, see the flight surgeon before you fly. He, in turn, will prescribe a specific medicine for your particular ailment and tell you whether you should fly or not. Don't try the weed as a cure for your ills.

When marijuana is smoked, one of the chemicals quickly enters the blood stream and, within minutes, begins to affect the user's mood and thinking. Its effects on emotions and senses vary widely, depending on such factors as the

user's expectations, the circumstances of use, and the strength and quantity used.

Usually time is distorted — five minutes may seem like an hour. Space may seem enlarged or otherwise distorted. As a pilot, you might try to land that Starlifter on a 900-foot wide runway, only to find out the hard way that it is only 200 feet wide and those dashes on the runway centerline suddenly become a solid line at the edge.

Sounds and colors sometime seem intensified. You may find yourself dreaming instead of flying. You may hear what the ground controller is saying, but you may not actually comprehend it.

You might go into fits of uncontrollable laughter or crying. You might also go into a panic — and, as all pilots know, panic in the cockpit is almost the ultimate in bad news.

Recent evidence has documented a loss of immediate recall, and difficulty in thinking and speech due to disorganization of memory. The effects of the "weed" can impair logical thinking, while at the same time, the user believes his judgment is perfect. Consequently, performing any complex task which requires good reflexes and clear thinking, such as flying an airplane, is particularly dangerous. As a result of use, a pilot might miss some checklist items or later wonder whether or not he threw a particular switch.

One of the primary arguments of pot advocates is that marijuana smoking is not as dangerous as using alcohol. Using an average dose, a marijuana "high" normally lasts three to five hours (highly variable and highly subjective) and reportedly does not produce a hangover as does alcohol. Though it's commonly accepted that neither has a lasting effect, recent research hints strongly that even moderate amounts of alcohol will cause irreversible brain and liver damage. Both the weed and the drink have their respective dangers in loss of motor coordination and impaired judgment. While a puff on a joint of weak, locally-grown marijuana may well be no more or less harmful than a drink of whiskey, a single drag on a strong reefer may stone the user as effectively as consuming a half-pint of hard liquor. And, when the two are mixed, the effects of each become more prominent.

Chronic, prolonged alcoholism is a serious problem, as is the prolonged usage of marijuana. Reports of marijuana psychoses and dementia have come from every country where marijuana has been used for long periods of time. Many foreign countries have marijuana "skid rows" much the same as the "skid rows" in this country which are populated mainly by winos and alcoholics.

When comparing use of the two — marijuana and alcohol — the marijuana user must also take into consideration the danger of going to jail. While use of the drink is legal, use of the weed is not.

Documented facts also prove that marijuana is not legal in any civilized country in the world. In many countries, especially in Africa, the laws dealing with possession and use of marijuana are much more harsh than in the United States. In Nigeria, the production and selling of marijuana is punishable by death, as is the case in Egypt.

Federal laws relating to marijuana in the United States were revised in 1970. Possessing or giving away marijuana is now a misdemeanor instead of a felony, and minimum mandatory penalties for these offenses have been abolished.

However, state penalties remain heavy. Possessing or giving away a small amount of marijuana may bring up to one year imprisonment or a $5,000 fine. Penalties for subsequent offenses become more harsh, and trafficking in marijuana may result in prison terms of 10 years to life or fines of $30,000 to $200,000.

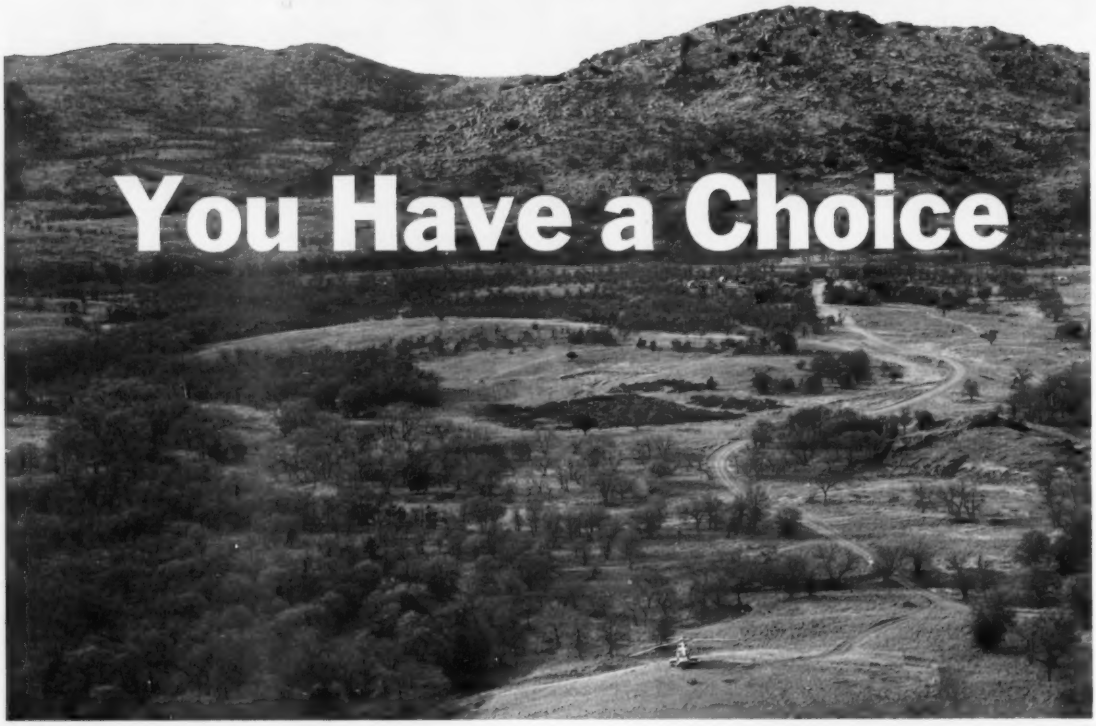
For the man in uniform, the use, possession, and sale of marijuana are violations of AFR 30-19 and could lead to a stiff penalty. Under the Uniform Code of Military Justice (UCMJ), you could receive a dishonorable discharge, total forfeiture of all pay and allowances, and two years confinement at hard labor. Flight crewmembers guilty of marijuana use face grounding for a minimum of one year.

Of all things known and not known about marijuana, two things stand out very clearly. First, if you use it at the wrong time and the wrong place, the results can be fatal. Second, if you get caught with it, it can ruin an otherwise brilliant military career.

Think about it! Is it worth the risk?

When your helicopter quits unexpectedly, it's nice to have a landing plan in mind.

You Have a Choice



by Maj Michael Tennery,
1550 ATTWg/SE

Except during those critical seconds after takeoff, helicopter pilots have some form of choice in selecting an emergency landing site. This does not mean a pilot should fly around preoccupied with losing an engine or the rotor blades. But it does mean he should develop some protective instincts and habits.

Plan

First, use your imagination in planning your route. In many cases, you are flying a single-engine aircraft. If the engine quits, down you'll go. Oftentimes, a couple of pounds of fuel or a few extra minutes will allow a chopper to fly around a lake instead of over it. Flying over a valley instead of along a ridge will frequently offer better emergency landing sites.

Second, consider altitude and airspeed. The fixed-wing philosophy of "the higher the better" does not necessarily apply to helicopter flying. Chopper pilots think more in terms of high enough to make an autorotation and low enough to get the aircraft safely and quickly on the ground in case of a critical malfunction. Airspeed can often be traded for altitude, but remember: as you increase speed you reduce your time to see and react. A pilot must leave himself enough altitude to select the best available landing area, avoid prominent obstacles, and still have time to initiate and complete a typical autorotation. We all have had friends in the helicopter world who aren't with us anymore because they flew low and slow over bone-crushing terrain. Check the minimum autorotation speed of your machine. Don't go below that speed. It is theoretically impossible to recov-

er when the engine quits at a lower speed.

Many times chopper pilots are presented with the problem of having to search in areas which offer very poor emergency landing sites. In these situations, airspeed is also influenced by how well a pilot can see what he is searching for. This often puts the chopper beyond reach of a suitable landing area.

The pilot is then left with having to accept the possibility of aircraft damage if an emergency occurs, so he should strive to make an emergency landing which he and his passengers can walk away from. The pilot must try to protect the cockpit and cabin areas. The following discussion suggests some ways to do this. Although the particular helicopter being flown and its mission will have considerable bearing on what a pilot can do, the decision is still the pilot's. This discussion is intended to stimulate thinking and encourage crewmember preparation. Remember, it's your choice!

Perform

When the emergency occurs, immediately judge the terrain within gliding distance for its energy absorbing capability. If sufficient altitude is available, head for the area which seems to offer the most suitable conditions without being immediately concerned with a specific spot. When the time available is very short, the choice may be simply to avoid individual obstacles, but it is still a choice as long as the pilot maintains control of his helicopter.

Open Terrain. Before instinctively heading toward open terrain, ask yourself:

- Can I reach the open area with normal glide, without being tempted to stretch it? (Note: The maximum glide speed is usually different from your power-off minimum rate of descent speed.)
- Does the surface permit a running landing in case of a hard, fast touchdown?
- If I must touch down fast, can I control the aircraft enough to prevent drift or the tail from swinging?
- If the surface is poor, do density altitude and gross weight permit a zero groundspeed touchdown, or must I aim for a minimum ground roll touchdown?

Trees (Forest). Accident experience shows that landing in trees is very hard on helicopters but not as bad as you might think on the people inside. When a tree landing is unavoidable, select a touchdown spot based on the following considerations:

- The height of a tree is less critical than the height above the ground at which the tree begins to branch. Tall trees with thin tops allow too much free-fall height before the aircraft reaches the cushioning branches.
- When faced with young or short trees, the most densely and evenly wooded area is preferred. This ideally allows the bottom of the helicopter and the rotors to create a cushioning effect at the same time as they contact the trees.
- In very tall trees try to get the fuselage evenly between the basic tree trunks before the rotor blades contact them.
- Landing in a sparsely wooded area may be more difficult than in a dense forest. The problem here is that individual trees act more like hard obstacles than energy absorbers. A rotor blade on one side will strike a tree while the other side is free. This tips the chopper over to land on its side.
- Brush-type vegetation is usually not a major problem, but it may hide tree stumps or large rocks.
- Dead trees are dangerous. They offer little energy absorption and tend to puncture the fuselage.
- In general, the best method of emergency landing in trees is first to have a zero or near zero ground speed. Try to have a high, rather than low, rotor rpm as you enter the tops of the trees. Keep the downward velocity as slow as you can.

Water. For years there has been a debate among helicopter pilots about what to do when you ditch a helicopter — roll it left, roll it right, don't roll it. What you do depends on the type helicopter you fly, but two things hold true for all of our helicopters. One, have all the doors open when you contact the water. Two, don't prematurely evacuate the helicopter; wait till the main rotor(s) stop.

Conclusion

Know your aircraft, and don't fly in the unsafe areas of the height-velocity chart. Pick your route and fly at a safe altitude. Approved procedures will usually result in less damage to the machine in a dead stick landing. Except on certain operational missions, it's your choice to fly at an altitude over a route that gives you an option in case of engine failure. If possible, leave yourself an escape route, but always anticipate where you would set the bird down should the need arise.

The seventh point in General Ryan's Safety Message called for meaningful review and analysis of aircraft accidents. Here are three mishaps, civil and military, with a common lesson.

Itty, Big, and Huge: A Tale of Three Ground Strikes

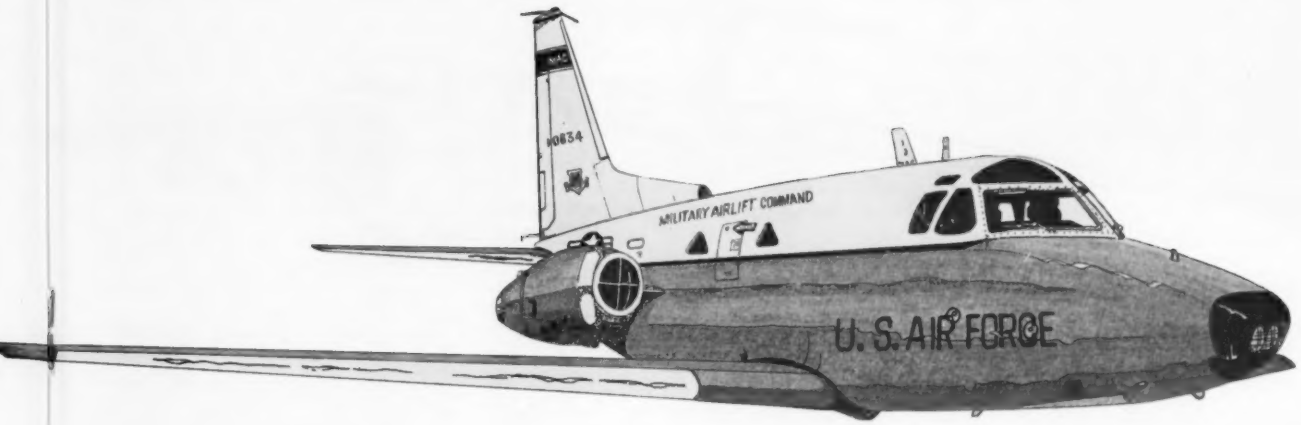
by Capt Phil Budd

Inadvertent Amphib

A small twin-engine jet trainer, crewed by two students and an IP, departed on a local training flight. The takeoff and climb to a 15,000-foot holding pattern were uneventful. After some airwork and simulated emergency practice in the holding pattern, the IP called for and received an over-water tacan penetration and approach to a nearby airfield. The crew started the penetration; during descent the IP asked for and received the latest altimeter setting. Several minutes later he called five-mile final. Two minutes later, at 3 miles on the DME, the aircraft contacted the water.

One engine flamed out, either because of water ingestion at impact or because of a throttle burst during recovery. The pilot established a climb and attempted an engine restart, unsuccessfully. The IP declared an emergency and, as they returned to home base, made a controllability check. Part of the right wingtip was gone, and the nose gear indicated safe but the main gear did not. The normal hydraulic system was also inoperative. They tried all the Dash One procedures but failed to get a safe gear indication. Then they made three tower fly-bys and were informed by people in the tower that the main gear were missing and the nose gear appeared to be trailing about 30 degrees.

The fire department foamed the runway and the IP made a



no-gear landing. After the aircraft slid to a stop, the three pilots smartly stepped through the over wing emergency exit — unhurt.

At the time of impact, the sky conditions were partially obscured, 300-foot broken, 600-foot broken, 1,500-foot overcast; visibility was two and a half miles in light rain and fog.

Findings

The investigating board determined the cause factor as supervisory error on the part of the IP who did not maintain proper vigilance during a non-precision approach. He allowed the aircraft to descend below the minimum descent altitude (MDA) to a point where a safe recovery could not be accomplished.

The board cited the pilot as contributing because he did not monitor his flight instruments during a critical phase of flight, thus allowing the aircraft to descend below MDA and strike the water.

The board further found that command directives possibly contributed because they did not establish realistic training minimums or provide adequate safety margins during initial qualification training. Nor did they require the third pilot to be used as a safety observer.

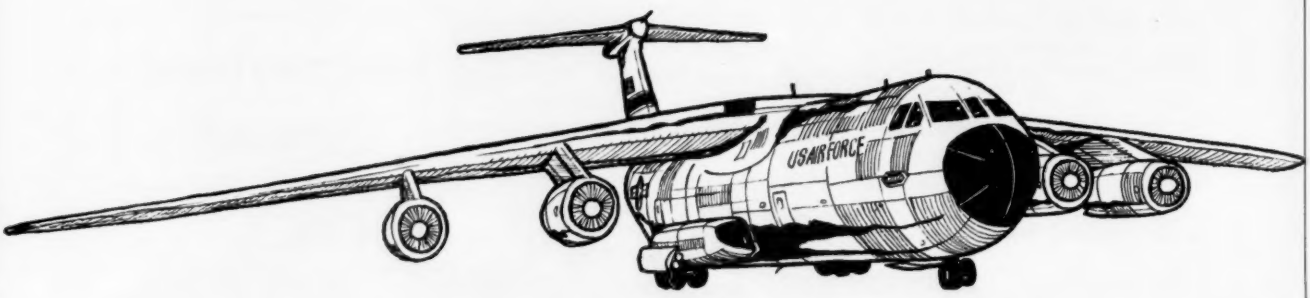
The only materiel factor found was a possible lag in the IP's altimeter.

Big Branch Basher

During an en route descent, the crew of a large four-engine jet were told to expect a PAR. The crew received further clearance to 2,000 feet and were given a vector to final. When the GCA final controller checked in, he began steering the aircraft left to line up with the final approach course centerline.

The weather at the time was reported as measured broken ceiling at 400 feet, 1,500-foot broken, 4,000-foot overcast, visibility of five miles, and thunderstorms. Here's the mental picture you should now have as the aircraft approaches decision height: it's slightly right of centerline, a little high and fast, and in sloppy weather.

The final controller ordered one last heading change to get the aircraft back on centerline, then he immediately said, "You are too low for a safe approach. If the runway is not in sight, go around." Seconds before this, the copilot had called "Land" (indicating that he had the runway in sight). Though the crew had the runway in sight, the pilot elected to go around. During the go around, they were advised that the weather was now below minimums. Observed weather was a 100 foot obscured ceiling and one-quarter mile visibility. The crew received holding instructions, held for approximately one



hour, then completed an uneventful, full stop landing.

So far so good; nothing really unusual. Then, as the crew deplaned, they discovered maintenance troops pointing out several tree branches embedded in the right wing.

Findings

The investigating board found that the branches had come from three small broken trees half a mile from the approach end of the runway slightly right of centerline. The tops of the trees were barely higher than runway elevation.

They also found that the radar controller had set the crew up for a higher and closer than normal pattern. (Normal pattern altitude is 1,500 feet.) The added 500 feet and short turn onto final forced the pilot to use an abnormal rate of descent. During the descent, the pilot's airspeed was also high. Garbled communications, crew fatigue, unfavorable weather conditions, poor use of all available nav aids, and late configuration, combined with the high descent rate and high airspeed, caused a pilot-factor mishap.

The board determined that because of factors mentioned, the pilot allowed the aircraft to descend to an unsafe altitude while transitioning from instruments to outside visual references. The board recommended that training in transitioning from instruments to visual references at decision height be given increased emphasis and that all pilots should achieve a thorough understanding of the proper instrument indications at decision height. Additionally, all glide path aids — VASI, ILS, GCA — must be used to monitor the final phases of the approach.

Seven Minutes to Disaster

The crew of a large three-engine jet were making an approach, and when they lowered the gear, the green nose gear position indicator light failed to illuminate. The crew recycled the gear in an unsuccessful attempt to obtain a safe indication. They began a missed approach and advised approach control they were directly over the field at 2,000 feet. Approach control gave the crew vectors away from the airport so the crew could troubleshoot the gear problem.

Six radio calls between approach and the flight crew were made in the six minutes from the missed approach to the time approach asked the crew if they were ready to turn around and come back in. The crew was then given a vector back toward the airport. Shortly thereafter, the first officer asked the captain, "We're still at 2,000, right?" The captain replied, "Hey, what's happening here?" Seconds later — seven minutes after the go-around — the airplane crashed.

Finding

During the go-around, the crew had climbed the aircraft to 2,000 feet and put it on autopilot in control wheel steering mode. Then they concentrated on solving their gear problem.

The first pilot said he'd fly the plane; the captain and third pilot attempted to see if the problem was just a faulty light in the nose gear position indicator. The captain also sent the flight engineer down to inspect the nose gear. Meanwhile, all three pilots got in-

volved with trying to change the light. As fate would have it, the pilots managed to jam the replacement bulb in sideways and (as evidenced by the readout of the cockpit voice recording) the frustration level of the crew began to build.

Although the first pilot was supposed to be monitoring the autopilot and aircraft instruments, he got involved in helping the other two pilots replace the defective bulb. During this time someone bumped the yoke and the autopilot disconnected. When the autopilot disengaged, an annunciator light illuminated on the pilot's console, but it went unnoticed. (The pilot's console is not readily visible from the first pilot's side, so the copilot would not have been able to see the illuminated light on the pilot's side.) The first pilot's autopilot console, hooked to a different computer than the pilot's, did not indicate the disconnect. Therefore, the first pilot — supposedly flying the airplane — had no annunciator light alerting him to the disengagement. The aircraft now began a gentle descent.

Meanwhile, the radar controller was busy with other arriving traffic and did not notice the automatic altitude readout on his radar screen change from 020 to 019 (2,000 feet to 1,900 feet).

Back in the cockpit, as the aircraft descended through 1,750 feet a chime sounded, indicating that the aircraft altitude was 250 feet different from what had been assigned. The cockpit voice recorder confirmed the chime, but apparently the sound went unnoticed by the crew busily trying to change a light bulb.

The plane's rate of descent was now increasing and the airspeed began to increase. At least four times, someone retarded the throttles. (The flight data recorder tapes confirmed that the auto throttles were not engaged.)

The altitude alert chime, the increasing airspeed, the autopilot-off annunciator light on the pilot's side — all went unnoticed as three pilots stewed over fixing a nose gear indicator light. No one was minding the shop.

The plane was at 900 feet msl when the radar controller noted it. But he did not make the standard call when noting that an aircraft was not at its assigned altitude ("verify present altitude"). Instead, the controller asked, " . . . How are things coming along out there?" The crew requested a return to the field, and the controller gave them a new vector to fly. Twenty-six seconds later the airplane crashed. The pilots never realized until three seconds before impact that they were not at 2,000 feet.

* * *

So what's the common factor in these three mishaps? Just this: when a flyable aircraft, operated close to the ground, has a distracted, inattentive, or unobserving crew, there's a good chance for a nasty ground strike.

C.R. TERROR

Oh, the bravest of men lift a glass now and then
In a toast to the few they revere,
And, whenever they do, you can bet that it's true
That they hold C. R. Terror's name dear.

Now, it surely sounds odd that this mishap-prone clod
Would be honored at all by the best,
But the virtues they praise, as their glasses they raise,
Are the lessons he's shared with the rest.

With his Rickles-type mirth and Falstaffian girth
He's been known as the Scourge of the Skies,
But this Clown of the Clan's an unusual man
Whose dumb antics are words to the wise.

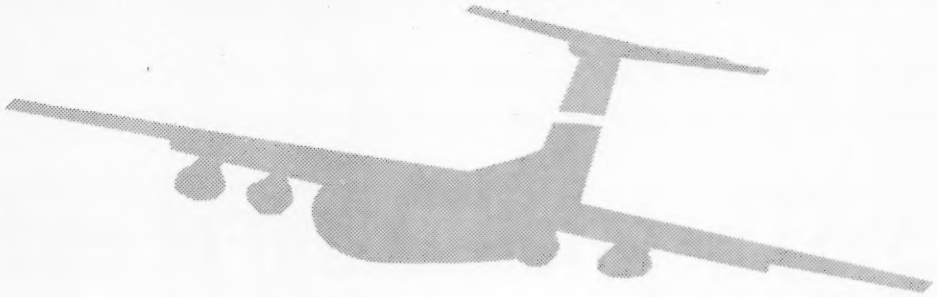
Yes, wherever he goes he keeps stepping on toes
And arousing the ire of a few.
But his message is clear: "**I'm** the goof-maker, hear?
"And I'm doing it all to help you."

Back in June, 'Fifty-four, C. R. lurched through our door
And demanded some space in our book.

He was pallid and weak; tears were wet on his cheek —
He'd just landed gear-up and was shook.

In the years in between (is it really nineteen?)
He has pulled some impossible pranks.

But through thick and through thin — and through gallons of gin —
He's remained at the front of our ranks.



He's checked out in them all, from the huge to the small,
And he's managed to bend every one.
Yet, no matter which bird, he still gets the last word
And survives when each mission is done.

Now, some utter a curse when his saga's in verse
And they cry, "Must we suffer with rhyme?"
But this only makes thrice. We're just adding some spice
To this rag, and it's well worth your time.

* * *

Come along with us now and we'll tell you all how
Old C. R. made his boo-boo for June.
With his Men of the Sky — Sam, Max, Blinky, and Ty —
He was tasked for a flight to Suisun.

It was rainy and black when he stepped from the hack
And delivered his body to Ops.
The departure at three left him lacking in glee,
And the plan was for multiple stops.

With the aid of his crew, he — somehow — muddled through,
And they filled all the squares as required.
But the Great One was slow (yes, his nose was aglow)
'Cause the party had left him quite tired.

In the weatherman's room he encountered more gloom
For the place was closed up for the night.
He let Sam make the call while he fumed in the hall
Where his eyes weren't abused by the light.

It was just as he feared — the predictions were weird,
And the weather en route was a brute.
But the mission was hot and the RON spot
Was the place for his favorite pursuit.

"Hurry up!" was his cry as he passed to the guy
In the window at Base ACP
All his papers and stuff. "Surely that weighs enough
"To allow us to leave DOV."

"Yeah, you've got all you need. Have a good one," agreed
The young captain, his checklist all run.
"Adios," shot our Ace as he spun in his place
And made tracks for the '141.

As he stepped from the bus, he observed quite a fuss
And a bevy of trucks 'round his bird.
"Is it safe to assume," he intoned through the gloom,
"That our plan to go fly is absurd?"

Blinky's answer was brief: "It's our radar set, chief,
"And they'll need half an hour for the fix."
"Oh, another thing, sir, they ain't done loading her,"
Offered Ty, "We'll be grossed out with bricks."

* * *

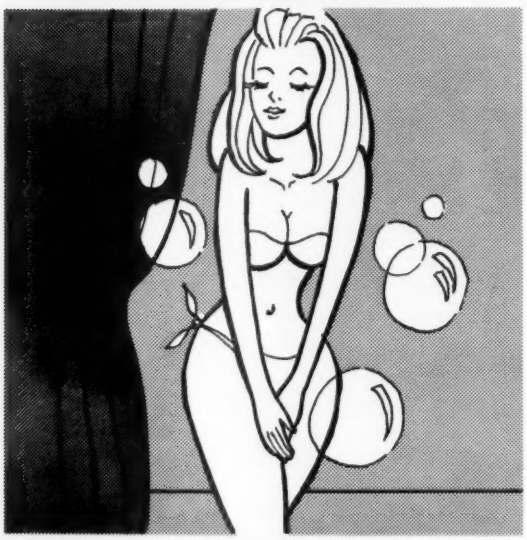
It was light in the east when they started the beast
And secured the last pallet of freight.
With a lurch and a roar from their ramp spot they tore —
And encountered an ATC wait.

There were traces of smoke from the man at the yoke
By the time they were cleared to depart.
With a cry of "Let's roll!" C. R. poured on the coal
And the bird pierced the clouds like a dart.

Climbing out wasn't nice: there was turbulence, ice,
and occasional torrents of rain.
When at last they broke clear, their next station
was near,
So back down through the garbage again.

Thus it went through the day — hurry up — and
delay;
Max complained they'd been bit by a snake.
By the time they hit Scott the whole crew was
half-shot
And their leader was barely awake.

"Okay, lads, listen here," C. R. spoke without cheer,
"There is only just one leg to go.
"Now, I know you're all beat (damn this mid-western
heat!)
"But I've got to meet Tassels, you know."



"Can we make it?" asked Blink. "I, too, need a cold
drink,
"And my eyeballs are starting to bleed."
"Never sweat it, my lad. Trust C. R., your old dad.
"An extension is all that we need."

C. R. dragged to the phone. Soon they knew by his
tone
An extension was what they had got.
"Come on, troopers, you're tough. This last leg
isn't rough
"And the mission is certainly hot."

With their four-motor scow set at thirty-five thou,
Not a man had a debonair pose.
They bored on through the night (with just
minimum fright)
Until Travis lay under the nose.

They descended to SAC, then were vectored on track
For a round-about pattern to 3.
"Okay, gang, scan outside," coached the Aeronaut
Wide,
"At long last we are able to see."

they touched down with a squeak — his best
landing all week —
And the crew breathed a sigh of relief.
What a day it had been! Glad it's over? Amen!
Any one for some booze and some beef?

They swung left at the end, and a Follow-Me friend
Led their Starlifter in toward the spot.
Just three hundred feet more 'til this crew, beat
and sore,
Could be off to the Q for a shot.

At the marshaler's sign, C. R. turned from the line—
And stared smack into headlights on bright.
Then he suddenly heard a discouraging word
From the man who was scanning the right.

"Stop it quick!" bellowed Max. As they froze in
their tracks,
Sergeant Downs said, "We've just dinged a tip!"
C. R. started to swear: "What the (bleep) was out
there?
"Man, that's all that we need on this trip!"

"Sir, it doesn't look bad," soothed the downy-
cheeked lad
With the wands, "It's just dented; no more."
Differed Sammy: "Oh, fine! It's a T-39
"With four stars on that plate in the door!"

* * *

Here the curtain descends on our narrative, friends,
So the mayhem is hid from our sight.
But a point we can make from the Round One's
mistake:
You can't quit 'til you've finished the flight.

When your blood sugar's low and fatigue makes
you slow
And you ache from your toes to your hair,
Don't begin to let down. In the words of our Clown;
"At the end's when you gotta **beware.**"

When you have a tension problem, try an aspirin. When a B-nut has tension troubles, the remedy is a torque wrench.

Nuts to the Calibrated Forearm

(adapted from Navy MECH)

After 1.3 hours of flight an HH-3E had to make an emergency autorotation to a grass field because of a main transmission oil leak. Cause: an over-torqued B-nut.

The crew of a T-29 cruising at 16,000 feet saw three electrical system failure lights come on. Fluid began leaking from the number two engine nacelle, smoke started pouring from the augmentor tubes, and the engine was shut down. Cause: an under-torqued B-nut on the alternator hydraulic pump pressure line.

Sounds like we might have a torque problem? Here are the facts for FY 72: as a direct result of improper torquing procedures, six people died, one man was seriously injured, one aircraft was destroyed, two more airplanes suffered major damage, and more than 70 almost-accidents were reported throughout USAF. That's reason enough to find out more about torque and its application.

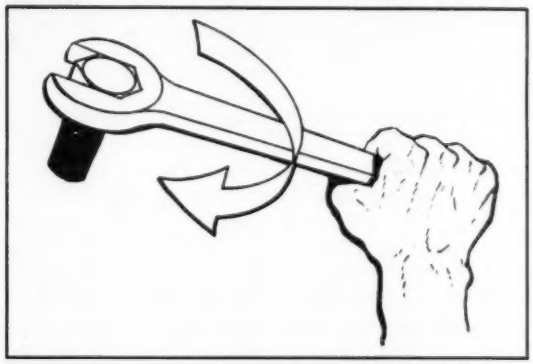


Figure 1. Torque is a turning force

What is it?

Torque is a turning force; by definition, "the torsional moment which tends to twist a body around an axis of rotation," (figure 1-2).

Great — but what does it really mean and why do we need it? For our purposes, torque is the rotational force applied to a fastener (such as a nut on a bolt or stud) to stretch or pretension it to a specific value. The calculated value of torque applied takes into consideration the strength of the fastener, the materials being bound together, and the anticipated stresses of normal operation that this fastener should be able to withstand without failure. For example, the trunnion bolts on the landing gear of an aircraft are designed to withstand the forces or stress that a normal gear of an aircraft are designed to withstand, plus an additional amount which is built in as a safety factor. When designed correctly and applied properly, components and torque values used will compensate for the forces applied and not even "feel" these forces as long as they do not exceed the anticipated value.

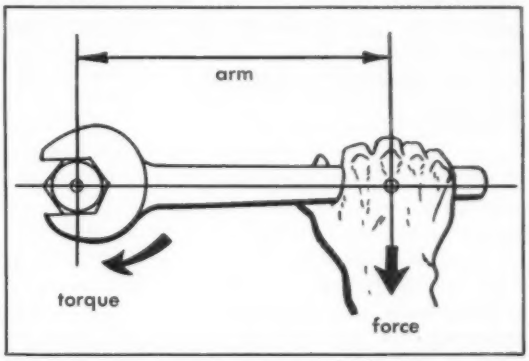


Figure 2. To compute torque, multiply the amount of force times the arm length

To better understand this, take a rubberband and note that it stretches in direct proportion to the amount of pull, up to its useful (elastic) limit. Any change in stretch shows a corresponding change in load; a constant amount of stretch shows a constant load. Now, wrap this rubberband tightly around two pencils. Assume that the pencils are now being held together with a force of two pounds. If you try to separate them with a force of one pound, what happens? Nothing that one can see — The pencils don't separate; the rubber doesn't stretch, and the rubber doesn't "feel" the separating force applied. Why? Because the rubberband

is preloaded to a greater force that the force being applied to separate the pencils.

The one-pound separating force reduces the pressure between the pencils (from two pounds to one pound) but the rubber doesn't "know" the difference. It will not stretch any farther until the force applied is greater than two pounds. If the band were made of metal instead of rubber, and if a load exceeding two pounds were applied intermittently, the metal would eventually fail from fatigue. Fatigue life is increased if the preload is equal to or greater than the alternating, imposed load.

Actual Practice

The solution to this problem sounds simple. Just apply and maintain a proper preload. However, a few complications arise in actual practice. First, the torque method, which is far from foolproof, is used to obtain a preload on a fastener such as a bolt. Obviously, the more you tighten the nut, the more you pull on the bolt. But, will all bolts holding a part get the same pull applied if each nut is tightened the same amount? Yes, but only if the conditions which cause resistance to turning the nut are equal — thread cleanliness, condition of the threads, condition of the mating surfaces. It is important to keep these conditions as uniform as possible by paying attention to the physical condition of the mating parts and by following recommended assembly procedures.

Drawbacks

The torque method has its drawbacks, but it is much better than guesswork and still the best method generally available in the field. It's the one to use until a better one comes along. But, while using it, keep in mind that it's the preload of the stud or bolt that we are after.

Undertorquing a fastener makes that fastener vulnerable to transient or alternating shear and tension stresses which may exceed the amount of applied preload. Such a condition, sooner or later, results in either a loose joint or fatigue failure of the fastener. On the other hand, overtorquing a nut applies excessive stress on the fastener, and failure could occur at any time.

Purpose

What is the reason behind the application of torque? The answer is that an aircraft in flight experiences certain combinations of shear and tension loads. The tension load originally built up by torquing may be increased by these externally applied loads. In such cases, the lower range of torque is used so that the combined loads will not add up to yield strength potential of the fastener. The higher torque values are standard for high-strength bolts but are used for AN and MS coded bolts only after it has been ascertained that no critical combination of shear and tension loads exists that might exceed their yield strength. These special torque requirements are spelled out in the maintenance manual for the aircraft affected.

Torque wrenches are an essential part of every mechanic's tool kit. For this reason, it is increasingly important that the limitation and possible uses of torque wrenches be thoroughly understood. Torque is based on the fundamental law of the lever . . . that is, force (F) times distance (D) equals the torque (T) about a point ($F \times D = T$) (figure 3-4).

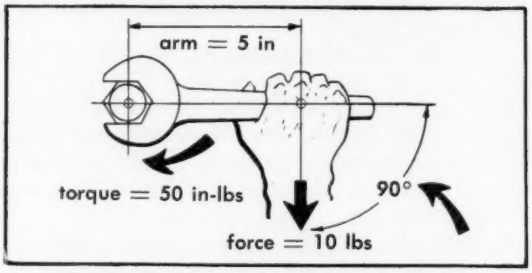


Figure 3. A sample torque computation

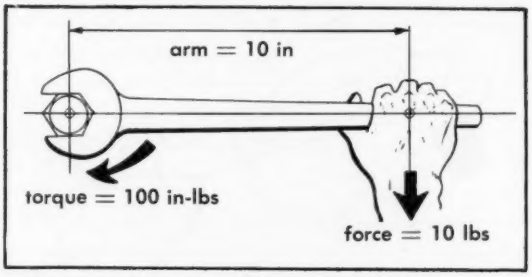


Figure 4. Doubling the arm doubles the torque

Size and Type

There is a practical limit to the size and capacity of any torque wrench. A normal person can pull with a force of about 100 pounds. If it were necessary to create 1,000 foot-pounds of torque a person would need a lever 10 feet long. Torque wrenches abnormally long are unwieldy, generally heavy, and often unsuitable to the working space available. Whenever torque beyond the range of approximately 600 foot-pounds is required, a multiplying device should be used, in conjunction with a normal size and capacity torque wrench. Because a multiplying device would naturally be a geared mechanism, care must be taken in selecting one to be sure that the device is as free of friction as possible and that the stated ratio actually exists.

Torque wrenches are manufactured in various

designs but there are only two basic types, the flexible beam and the rigid frame.

The deflecting element (figure 5) is the lever on

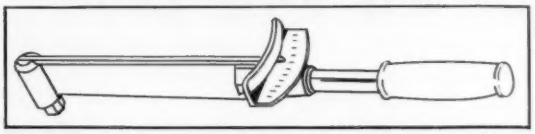


Figure 5. Deflecting beam type torque wrench

the flexible beam type of torque wrench. In use, the lever bends (deflects) when a load is applied. On the most common model, a pointer which is attached to the socket drive-end remains straight when the beam deflects, and it indicates the applied load as torque on a graduated plate attached to the handle. (Note: Flexible beam torque wrenches are approved for torque measuring, friction, and holding operations only. Do not use for applying torque unless specifically authorized for a special application.) Other wrenches of this type may have a graduated dial instead of an indicator plate. Audible or sensory indicators are sometimes provided in addition to the indicator plate or dial (figure 6).

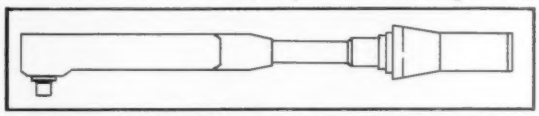


Figure 6. Audible-sensory type torque wrench

The location of the grip on a deflecting beam type of wrench determines the length of the lever, and therefore the accuracy of the torque reading. For this reason, some flexible beam wrenches are provided with a pivoted grip to ensure that the point of load application is maintained at the proper distance from the socket drive.

The deflecting element of a rigid frame torque wrench is enclosed in a frame which functions as the lever. The deflecting element actuates a needle on a graduated dial that indicates the applied torque (figure 7).

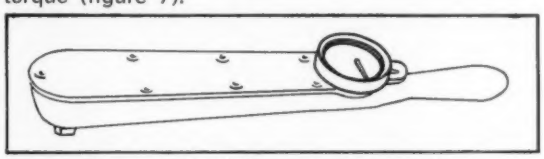


Figure 7. Rigid frame torque wrench

Care of a Torque Wrench

It is important to recognize that a torque wrench is a tool with a force (torque) measuring gage built into it. This permits a measured stretch or preload to be put in a threaded fastener. Torque wrenches of both the rigid frame and flexible beam types (having circular dial indicators) should not be dropped or stored in toolboxes with other tools. Special caution should be taken when storing an adjustable micrometer torque tool. This type of torque tool should always be stored at the lowest increment torque value. Example: Wrenches measuring from 0-150 inch-pounds should be stored with a scale setting of zero, while a wrench measuring 150-500 inch-pounds should be set at the 150 inch-pounds increment setting when not in use. The wrenches often have a rack and pinion movement, gear train, or other fragile mechanical multiplying devices. These mechanisms, like those of a clock, may continue to function after the tool has been subjected to jarring in a toolbox or to an accidental drop, but you could hardly depend on the wrench for accuracy.

All wrenches should be kept clean and free of corrosion. If corrosion is allowed to attack any measuring element, a dangerous inaccuracy could result and the tool may become a hazard.

Under no circumstances should a user attempt adjustments on a torque wrench that may cause variations in accuracy. If the operator notes erratic movements of the indicating pointer, the torque wrench should be immediately checked for accuracy on a reliable torque tester.

Check for calibration. A torque wrench is a precision measuring tool and, like all precise tools, does not always remain in calibration. Rough handling and even long storage without use may at times throw it out. To be sure that a torque reading is accurate, make certain that the wrench you choose is in calibration. All maintenance activities are required to have a system in effect for periodically checking the calibration of all torque wrenches. Branch chiefs will ensure tools and equipment requiring calibration are scheduled and calibrated per instructions in AFM 66-267 and TO 00-20-10-6. A monthly machine schedule is published to ensure timely accomplishment.

Check Your Torquing!

Everybody can make a mistake occasionally. So, don't depend on your own ability to be right every time. The consequences of one mistake on your part are too serious!

Have all your torquing checked by your crew leader, supervisor, or quality control inspector. It doesn't really matter which one does it—what does matter is that another qualified man other than yourself takes a second look at the job—to be sure!

For more information on torquing and torque tools, review TO 32B14-3-1-101, Torque Indicating Tools, and TO 1-1A-8, Structural Hardware.

Magellan's Place in the Box

by Maj Norman W. Smeenk, 443 MAWg/DOT

Flying machines have captured the imagination of the world: Kitty Hawk — the Spirit of St. Louis — the X-1 — the Lunar Landers. The history of aviation is full of many exciting and memorable events.

It has also been full of practical applications, and today's aviation has become a serious and integral part of our daily lives. Because of this, technological advances such as size, capability, and performance of new airplanes are probably taken too much for granted by the vast majority of the public. The average citizen (or the average ground-pounder in the military) is not aware of the intense and complicated training which crewmembers go through. Nor does he realize that much of this training is completed in aircraft simulators. This has long been true for pilots, but now navigators are learning their trade in those boxes on the ground. This article will briefly explain the novelty of having a navigator's station in a simulator and the training benefits derived from it.

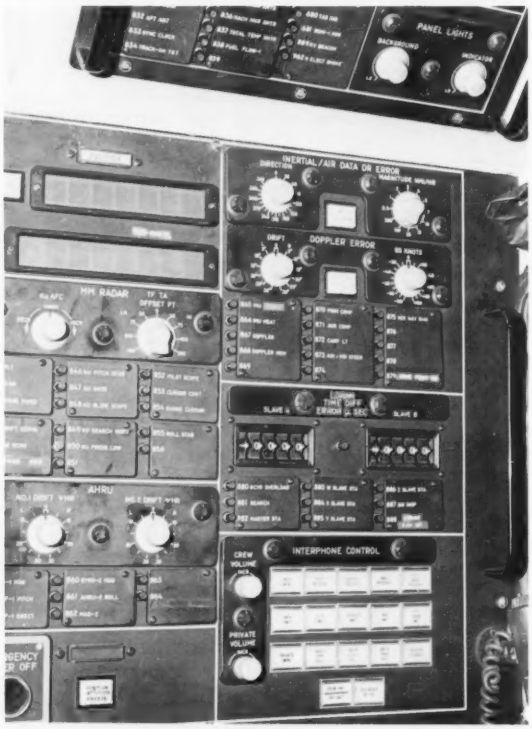
During the last few years, the Military Airlift Command received a large share of the new airplanes entering the Air Force inventory. With this, MAC training problems grew in proportion to the size and complexity of the new airplanes. As an example, the C-5, the largest and most sophisticated and complex airplane ever built, challenges every crewmember. To operate this aircraft efficiently, all crewmembers must receive careful, meticulous training. Each aircrew member must be fully able to perform his important role in safely managing this airplane through the skies. To achieve this, MAC uses cost effective and efficient flight simulators. But the C-5 simulator is different: it has a navigator station.

History

MAC became involved in the basic design of the C-5 mission flight simulator in 1967. Building the simulator proved to be almost as hard as building the actual C-5 flight deck itself. Obviously, this simulator would need a pilot, copilot, and flight engineer station. But — unheard of until now — a navigator station was to be incorporated into the simulator. A new era for training for MAC navigators was at hand.

Approximately three years have passed since the first C-5 simulator became operational, and now is a good time to evaluate its impact in training C-5 navigators. Unquestionably, simulators save both time and money. They provide the necessary link between the classroom and the airplane.

Some crew positions have always benefited more than others from the training conducted in a simulator. When evaluating this premise among the crew positions of the C-5 simulator, it appears that the navigator, the newest member on the simulator flight deck, has inherited the greatest benefit. Why is this true? Don't the pilots gain the most? Don't



From the outside the C-5 simulator doesn't look much different than most multi-engine simulators. But the inside is different. This is a portion of the nav panel.

the pilot and copilot have to be knowledgeable about all aspects of the airplane?

Certainly, but progress toward full pilot qualification can go just so far in the simulator. The simulator does not realistically simulate three-dimensional flight. Although the visual image transmitted on the simuator's cockpit windows aids greatly in simulation, it does not equal the real visual world. The pilots must be placed in the actual airplane to progress further toward full qualification. The flight engineer is also limited by the quantity of training that can be conducted in the simulator, because he has many duties that take place away from the flight deck.

Benefits

However, the limitations which affect simulator training of pilots and flight engineers are almost entirely missing for the navigator. In the C-5 simulator, the entire role of C-5 navigation, except for basic celestial navigation, unfolds. (There is no sextant provision in the simulator; sextant skills are a prerequisite of entering C-5 training.) In the C-5, the navigator's tasks are to communicate with his computers and with the outside world electronically. He even communicates with avionic components in other areas of the airplane to analyze the degree of an indicated malfunction. But simply stated, the navigator's main role still involves answering these questions: Where have we been? Where are we now? And where are we going? This role remains the same whether the airplane is climbing, turning, descending, or flying straight and level. His role remains the same whether the visibility in the outside world is zero-zero or clear and one hundred.

In training a navigator, the instructor navigator must first ensure his student is proficient in using each piece of equipment. He can check this easily in the simulator, for all the controls, indicators, and instruments are identical to the airplane's navigator station. Next, the instructor must teach the student to tie together the operation of the different components so that he becomes efficient in using them collectively. And finally, the instructor introduces real-world malfunctions and limitations which add depth to the student's ability to perform his duties. Here is where the instructor sees the greatest value of the simulator, for the simulator's main computer produces very realistic signals, indications, and presentations.

A well-motivated simulator instructor is the key to effective training in the malfunctions and limitations phase. He has the potential to measure precisely the exact degree of a student's knowledge and proficiency in using C-5 navigation systems. When he induces problems that are timely and logical, he can produce a sense of reality in the mind of the student. The student navigator, more than any other crewmember, can be made to forget that he is in a simulated world.

In the past, the instructor was at the mercy of the maintenance man when he and his student arrived at the airplane for a training flight. The instructor usually was forced to live with one of two options: a component worked or it didn't. If a unit was operational, the instructor had to verbally test the student's knowledge of what he would do if it didn't work — and if it didn't work, he had to find out if the student knew what to do if it did. In the simulator, the instructor has unique operational reliability which provides malfunction-free components. Then after the student demonstrates competence with normally operating components, the instructor can insert limitations and malfunctions as needed or desired.

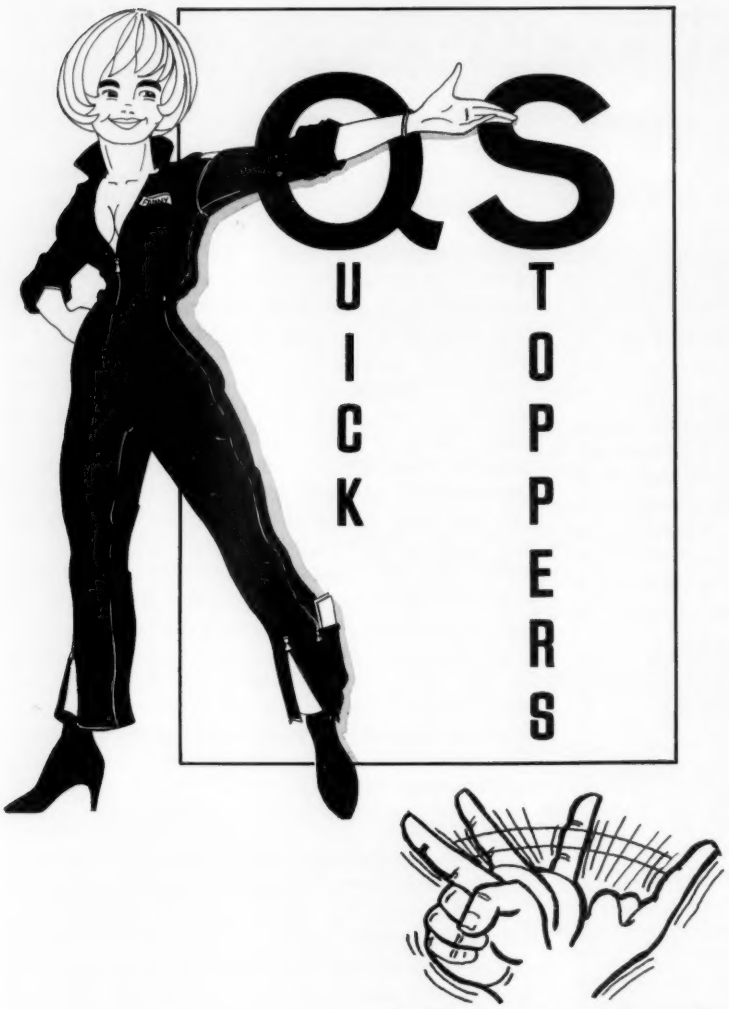
The simulator exposes the student to all the tasks associated with his duty. This simulator capability completes the navigator's basic training experience. If his instructor has applied the correct principles of instruction, the right amount of motivation and realism, and a fair range of logical malfunctions, then the simulator has been used to its full potential and the student should be close to achieving fully-qualified status.

More Features

The C-5 simulator offers many more training features. For example, a polar environment can be simulated, allowing the navigator to practice sensible grid navigation. Also, in the near future simulated aerial refueling will provide crew experience prior to an actual aerial refueling mission. And finally, almost the entire spectrum of a combat airlift mission will be practiced in the flight simulator. Features such as contour mapping, terrain following, terrain avoidance, and air drop techniques will be realistically provided by the C-5 simulator.

Wrap-Up

Pilots and flight engineers have been reaping simulator training benefits for years, but most navigators have never known the benefits from a simulator training environment. Because a unique simulator training experience was never available in the past, most navigators simply received classroom training and then transferred directly to the aircraft. But for those C-5 navigators who have experienced the phenomenon of a modern training device, MAC navigator training has finally come of age.



Push Me - Pull Me

Day in and day out, pilots pull, push, and twist the flight controls and never really expect them to operate in other than a normal manner. This is as it should be. Imagine the surprise, then, of an airline captain who accelerated 210,000 pounds of airplane to its rotation speed of 131 knots, applied back pressure to the elevator control column, and received no response! The takeoff was aborted successfully.

After pulling off the runway, the crew made a control check which revealed that the elevator control column could not be moved aft, indicating either a stuck or frozen elevator. Investigation revealed the elevator control crank had been installed upside down during maintenance work just prior to this "flight."

— Flight Safety Facts and Analysis

Which Way is North?

About 40 minutes after departure, the crew of a civilian jet cargo hauler noted that both remote compass systems were precessing and showing large errors. One system indicated up to 40 degrees left while the other indicated up to 40 degrees right of course. The crew wisely elected to make a precautionary no-gyro surveillance radar landing at an intermediate point for maintenance.

Though extensive trouble-shooting did not disclose any malfunction, the compass errors remained. Magnetic cargo? Apparently not; at least the paper work did not reveal any magnetic materials on board. Just to be sure the airplane was unloaded, and when the thirteenth pallet was removed, both compass readings returned to the correct bearing.

Inspection of the thirteenth pallet disclosed that it contained 43 cartons holding 350 pounds of electronic equipment. Loaded in the rear of the fuselage, near the compass flux valves, this cargo had caused an emergency flight situation.

— Flight Safety Facts and Analysis

Hissed to a Stop

The crew of a jumbo jet aborted their takeoff at about 100 knots because they heard the hissing sound of rushing air. Since it sounded as though a door had suddenly opened, the takeoff was immediately rejected.

Upon investigation the crew quickly found that the hiss was coming from the flight engineer's oxygen mask, which had somehow been actuated to *emergency* flow. Just how is not known. However, the flight engineer speculated that the selector may not have been fully positioned to the *normal* detent and somehow "jiggled" into *emergency*.

In any event, the incident is a "share your experience" worth remembering and it presents a good case for making sure your selector is fully seated in the *normal* detent.

— *American Airlines FLIGHT DECK*

Ignore It

When a mishap happens or an unsafe condition exists, you normally submit an incident or hazard report. If the same situation comes up again, you generally get disgusted and stop writing reports.

This in turn leads the powers — that — be to think the situation has been corrected. Both you and the powers have fallen into the old cliche "If you ignore it, it's bound to go away" trap. Obviously, the trouble is still there — unknown to them and unflagged by you.

Keep the reports coming — otherwise we all get complacent.

— Strike Command Flight Safety Review

Thoughts

It has been estimated by safety engineers that an unsafe act can be committed an average of 300 times before an incident occurs.

— Flight Safety Foundation

But you may be the three-hundredth one — so do it right the first time.

— The MAC Flyer

after deadline . . . .

LETTERS WE LIKE TO GET -- Within the space of a week, the command section received three letters which brought smiles of pride. Two of the letters announced that MAC had won major Air Force awards, and the smiles broadened when we learned that this was the first time any major command had won both awards for the same year.

Dear General Carlton:

It gives me great pleasure to select the Military Airlift Command as winner of the Secretary of the Air Force Safety Award for 1972. Your command was considered to have the best overall accident prevention program of all major commands with a calendar year total of 200,000 or more flying hours.

The record of safety accomplishments of the Military Airlift Command was impressive. In particular, the low major and minor accident rates and significant improvements in all five categories of ground accidents evaluated were most commendable. Such achievement is indicative of strong commander involvement coupled with professionalism and motivation of all personnel whose combined efforts contributed to the command's safety record. I am pleased to select an organization that has reflected credit upon itself and the United States Air Force and extend my personal congratulations to you and each member of the Military Airlift Command.

Sincerely,

Robert C. Seamans, Jr.
Secretary of the Air Force

MAC (Gen Carlton)

It is my pleasure to notify you that your command has been selected as recipient of the Major General Benjamin D. Foulois Memorial Award for 1972. MAC was judged to have had the most effective aircraft accident prevention program of all major commands.

The award will be presented at the United States Air Force Academy during the annual meeting of the Order of Daedalians, at 1900, 23 June 1973. The Order of Daedalians will contact you directly requesting your attendance at the ceremony.

I extend my personal congratulations to you and all members of your command who through their safety awareness, involvement, and high level of performance achieved this outstanding record.

Gen John D. Ryan
Chief of Staff

Dear General Robbins:

I want to express my admiration for the total professionalism displayed by all MAC people I came in contact with at Dover and Rhein-Main during my recent trip.

I thought your aircrew members were particularly impressive. Young captains were the ACs on each aircraft. There was no doubt in anyone's mind who was chief honcho on board. I observed your crews responding to abort situations three times: once charging down the runway, once after getting airborne, and again in line-up position. In each case the total crew response was instant, proper, and calm. No one tried to temporize policy and regulations. The decisions were made, the action taken, and the ALCP informed. I repeat and I emphasize, someone taught those youngsters well. Someone ought to be damned proud to have achieved the spirit, skill, morale, and competence displayed by your crews.

I haven't even mentioned the young feller that was AC on the C-5 from Rhein-Main to Dover. The little character was on top of everything, was quite obviously proud of himself and his bird, and had those dozen crewmembers jumping through their paces as if he were a drill sergeant.

So with profound respect, my hat's off to MAC.

As ever,

Brig Gen Robin Olds
Director, Aerospace Safety

As General Carlton commented, "Well done to all."

TROPHY TROUBLES -- According to one lower echelon source, some of the safety trophies and plaques sent out by our contractor have arrived in less than satisfactory condition. If your unit has received damaged or poor-quality safety awards hardware, please send us a report of the details.

SHARP EYES -- 63 MAWg maintenance and safety folks spotted these goofs on page 23 of our May issue:

* The maintenance stand doesn't have guard rails installed.
* The jacket on the edge of the stand could be a tripping hazard.
* The engine trailer is being jacked with a man standing on it.
* The man working under the cowling is standing on the edge of the rail.
* The half-hidden lad has no hat.

Okay, all you wrench drivers -- if you caught us, great! If not, call your unit safety NCO and ask him to visit your work area before you have your accident.

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